Liquidity Constraints and Entrepreneurial Performance*

by

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ABSTRACT: If entrepreneurs are liquidity constrained and cannot borrow to operate on an efficient scale, those with more personal wealth should do better than those with less wealth. We investigate this hypothesis using a unique datset from Norway. Consistent with liquidity constraints being present, we find a strong positive relationship between founder prior wealth and start-up size. The relationship between prior wealth and start-up performance, as measured by profitability on assets, increases for the main bulk of the wealth distribution and decreases sharply at the top. We estimate that profitability on assets increases by about 8 percentage points from the 10th to the 75th percentile of the wealth distribution. This suggests an entrepreneurial production function with a region of increasing returns. Liquidity constraints may then stop entrepreneurs from being able to exploit a "hump" in marginal productivity. From the 75th to the 99th percentile returns drops by about 10 percentage points. This suggests that an abundance of liquidity may to do more harm than good.

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1 Introduction

One of the oldest ideas in the study of entrepreneurship is that entrepreneurs may be liquidity-constrained due to capital market imperfections and therefore unable to establish a venture at an efficient scale. To illustrate this point, Adam Smith used the example of the owner of a small grocery store: He must

> "be able to read, write, and account, and must be a tolerable judge too of, perhaps, fifty or sixty different sorts of goods, their prices, qualities, and the markets where they are to be had cheapest. He must have all the knowledge, in short, that is necessary for a great merchant, which nothing hinders him from becoming but the want of sufficient capital." (Wealth of Nations, bk. 1, ch. 10).

While a large body of research has investigated whether liquidity constraints can hinder start-up formation, much less is known about whether lack of liquidity may impair performance conditional upon entry.[1] To address this question, we use a unique dataset from Norway, which combines accounting information about the start-ups with detailed background information about the founders.

Consistent with liquidity constraints being present, we find a strong relation between the founder's prior wealth and start-up size, controlling for other entrepreneur characteristics. The relationship between founder wealth and start-up performance, as measured by profitability on assets, increases over most of the wealth distribution and decreases sharply at the top. These findings suggest that a moderate amount of liquidity may propel entrepreneurial performance, but that an abundance of liquidity may do more harm than good.

The model of Evans & Jovanovic (1989) provides a useful reference point for our empirical analysis. In Evans & Jovanovic, individuals can supplement their personal

[1] The literature on liquidity and entry into entrepreneurship includes e.g., Evans & Jovanovic (1989), Holtz-Eakin et al. (1994b), Dunn & Holtz-Eakin (2000), Paulson et al. (2006), and Campbell (2006), who all find a strong role for liquidity constraints in deterring entry. Hurst & Lusardi (2004) finds a positive relationship between household wealth and entry into entrepreneurship only at the very top of the wealth distribution.

stake in the start-up by borrowing. Wealth plays the role of collateral. Entrepreneurs whose financing need exceeds the total available funds are defined as constrained, and entrepreneurs whose financing need falls short of available funds as unconstrained. Evans & Jovanovic (1989) predicts a negative relation between wealth and profitability for the constrained entrepreneurs, and a zero relation between wealth and profitability for the unconstrained entrepreneurs. While the first prediction relies on the assumption of a decreasing returns to scale production technology, the second prediction is independent of assumptions made on technology.

Through fitting a fourth-order polynomial in wealth, we estimate that profitability on assets increases by about 8 percentage points from the 10th to the 75th wealth percentile. This result suggests an entrepreneurial production function with a region of increasing returns. As such it stands in contrast to the Evans & Jovanovic (1989) model, and it suggests that liquidity constraints could stop entrepreneurs from being able to exploit a "hump" in marginal productivity. The result is particularly important in view of the recent findings by Hurst & Lusardi (2004). Using US data, they show that there is almost no relation between household wealth and the decision to start up a company. They conclude that liquidity constraints are "not a major deterrent to business formation" (p.344). They acknowledge that "the inability to borrow may prevent households from starting businesses at their optimal scale", but do not address this question due to data limitations. In the present paper we show that, for a main bulk of the wealth distribution, liquidity constraints incur a large, negative effect on the size and profitability of start-ups.

At the top of the wealth distribution, our estimates suggests that the profitability on assets drops by about 11 percentage points from the 75th to the 99th percentile. That profitability decreases on some interval of the wealth distribution is what one would expect from the Evans-Jovanovic model where marginal profitability decreases as start-ups reach their efficient scale. It is, however, puzzling that profitability on assets falls sharply in the

region where entrepreneurs are least likely to be liquidity constrained.

One interpretation can be that entrepreneurship gives non-pecuniary benefits more likely to be purchased by wealthy households, such as more flexible work time or more autonomy (Hamilton, 2000, Moskowitz & Vissing-Jorgensen, 2002, and Hurst & Lusardi, 2004).[2] If wealthy and less wealthy individuals produce business ideas of similar quality when controlling for human capital, we would from entrepreneurship being a luxury good expect wealthy individuals at the extensive margin to start up ventures that are less profitable.

While Evans & Jovanovic (1989) does not specify the underlying friction leading to liquidity constraints, de Meza & Webb (1992) and Bernhardt (2000) show that adverse selection in the market for entrepreneurial finance can lead to credit constraints and suboptimal investment levels.[3] Aghion & Bolton (1997) shows that moral hazard can have a similar effect. Other papers make more sophisticated use of the Evans & Jovanovic (1989) model than we do. Paulson et al. (2006) uses data from Thailand to estimate a structural model that encompasses both the Evans-Jovanovic limited liability and the Aghion-Bolton moral hazard model, and finds that moral hazard is the main source of credit market imperfections. Our focus will be different from Paulson et al. (2006); while they study why there are liquidity constraints, we study the consequences of liquidity constraints for start-up size and profitability.

There have been few attempts to investigate empirically the effect of founder liquidity on start-up performance. Evans & Jovanovic (1989) finds that a doubling of founder wealth is associated with a 14 percent increase in self-employed earnings (Table 3, p.

[2] In support of this view, Hamilton (2000) finds that entrepreneurs could make more as paid workers, while Moskowitz & Vissing-Jorgensen (2002) finds that the returns to private equity is not higher than the returns to common equity, in spite of offering much worse diversification.

[3] A closely related literature contain models where credit constraints can restrict the number of projects implemented rather than their scale (e.g., Stiglitz & Weiss, 1981, de Meza & Webb, 1987, and Bernanke & Gertler, 1990). Gertler & Gilchrist (1994) contains early evidence on the importance of credit constraints for small firms in the U.S. Aghion et al. (2007) contains some recent international evidence using firm-level data.

820), but does not control for the investment level nor that wealthier founders tend to have higher effective human capital. Holtz-Eakin et al. (1994a,b) and Blanchflower & Oswald (1998) point out that using wealth as a proxy for liquidity is problematic if traits that make a person more likely to accumulate wealth also makes him a better entrepreneur. In the present paper we show empirically that omitted human capital controls can seriously bias the estimated effect of wealth on performance. Holtz-Eakin et. al. (1994a) try to avoid such a bias by using a data on the tax receipts of a sample of entrepreneurs that had received inheritances from large estates, and find that a $150,000 inheritance increase increases the survival probability by 1.3 percentage points (1994a, p. 53). Their identification strategy rests on inheritance providing exogenous variation in liquidity. This has been criticized by Hurst & Lusardi (2004) who shows that inheritances predict *past* transitions into entrepreneurship as well as future ones. Having a rich set of sociodemographic background variables, our strategy is to avoid the omitted variable bias by using a battery of controls for potential underlying traits correlated with wealth. We use standard human capital variables such as age and education. In addition we use the entrepreneurs previous wage history to control for "unobserved" ability. While our focus is on the relation between liquidity and start-up profitability, we also analyze the relation between liquidity and entrepreneurial wages, and between liquidity and survival. We find no relation between liquidity and entrepreneurial wages, once human capital is controlled for. Our results on survival are consistent with the results on profitability.

The rest of this paper is organized as follows: The next section describes the data. Section 3 discusses our empirical strategy. Section 4 contains the empirical analysis, and Section 5 concludes.

2 Data

We construct a dataset consisting of incorporated firms started up between 1994 and 2002 in Norway.[4] The dataset contains accounting information on the start-ups in addition to personal information about the founders based on tax records and other public registers. The dataset is compiled from three different sources.

1. *Accounting information from Dun & Bradstreet's database of accounting figures based on the annual financial statements reported by the companies.* This data includes variables such as sales, assets, profits and 5-digit industry codes for the years 1994-2005.

2. *Data on individuals from 1986 to 2002 prepared by Statistics Norway.* These records include the anonymized personal identification number and yearly sociodemographic variables such as gender, age, education, wealth, interest payments and earnings split into labour income and capital income.[5] We use the Statistics Norway data to construct measures of founder background and founder wage income after starting up a venture.

3. *Founding documents submitted by new firms to the government agency 'Brønnysundregisteret'.* These data includes the personal identification number of the founders, total capitalization of the company, and each founder's respective ownership share.

[4] We focus on new incorporated companies rather than self-employed because incorporated companies trace out much more detailed data on the business unit, such as investment levels and industry code classification. Moreover, since setting up an incorporated company carries tax benefits relative to being self-employed (e.g., more beneficial write-offs for expenses such as home office, company car, and computer equipment) incorporation status will be more tax efficient than self-employed status except for the smallest projects. The formal capital requirement for registering an incorporated company was NOK 50 000 in equity until 1998 and NOK 100 000 thereafter. NOK 50 000 is equivalent to about 6 300 Euro. Also, incorporated companies are required to have an external auditor certifying the accounting statements in the annual reports, which makes the reliability of the data higher than for self-employed.

[5] Earnings and wealth figures are public information in Norway. This transparency is generally believed to make tax evasion more difficult and hence our data more reliable.

Using the founding documents we define an entrepreneur as a male with a majority stake, i.e. more than 50 percent of the total shares, in a newly established incorporated company. Restricting the sample to majority owners makes us avoid the problem of defining liquidity when dealing with multiple founders with different levels of wealth. The included founders own on average 83 percent of the company at the start-up date. Other advantages include avoiding the problem of how to deal with nominal founders such as "sleeping spouses". Restricting attention to males avoids well-known measurement problems with female labor market participation. Only 7 percent of the founders are females and hence excluded.

An adverse consequence of the low barriers to starting up an incorporated company and its favorable tax treatment, is that many start-ups in Norway are tax-shelters or have minimal activity. This is particularly common within real estate. We deal with this problem in two ways. First, we over-sample manufacturing and IT. We believe that tax shelters are less likely to occur in these industries. Moreover, over-sampling these industries creates high variation in the sample since, relative to manufacturing, the IT industry has a high proportion of service-oriented firms and a low capital intensity. We selected all start-ups within the high tech sectors NACE 23-35 and 72 from 1994-1998, and all start-ups within manufacturing and IT, NACE 15-37 and 72 from 1999-2002. We added a random 25 percent sample of other non-financial private sector start-ups from 1999-2002. We expanded the sample after 1998 because the cost of collecting data for the more recent period is lower. Second, to further reduce the share of "empty shells" we only include companies that have at least NOK 500 000 in sales and at least two persons employed during one of the first two years of operation. To avoid sampling empty companies is important as the incorporation documents have to be hand-collected by research assistants at a non-negligible cost per unit. However, our selection criteria are

deliberately set low in order not to exclude companies of interest.[6]

For each start-up selected in Dun & Bradstreet's database we compile a list of founders based on the founding documents.[7] Next, we match in the founders' associated sociodemographic information from the public registers supplied by Statistics Norway. Due to alterations in the reporting requirement in 1998 we were able to match around 80 percent of the founders in companies founded after 1998 and around 20 percent before. Altogether we have a sample of about 1500 unique founders and 10 700 founder-year observations. In the analysis we lose about 200 founders due to missing variables.

We note several advantageous features of our data compared to data used in earlier work on entrepreneurship. First, we have access to a long panel with yearly and multiple measures of wealth and multiple measures of returns. This enables us to perform a variety of robustness tests. Second, we have detailed data on the wage history of the founders. This enables us to control for human capital and the entrepreneur's opportunity cost to a much greater extent than the previous literature.[8] Third, we have access to the industry codes of the start-ups, so that we can control for industry-specific effects. In contrast, industry codes are rarely or ever available in data on the self-employed commonly used to study entrepreneurship. Fourth, our sample consists of newly started companies so that we do not need to worry that wealth comes in the form of a business inherited from parents.

[6] We acknowledge our selection criteria create a potential bias, since there is a tendency to under-sample companies that do not generate sales the first few years.

[7] Note that some founders are not employed in the firm. We do not exclude these founders since this is a characteristic that may be correlated with performance and provides interesting variation in entrepreneurial behaviour.

[8] Previous studies have had limited data on previous labor market success. For example, Holtz-Eakin et al (1994a) only have access to previous receipts as entrepreneur. This does not relate to what the entrepreneur did before starting up a company. Paulson et al. (2006) uses years of education as proxy for ability.

3 Empirical strategy

3.1 Measuring liquidity

Following previous work by e.g., Evans & Jovanovic (1989) and Hurst & Lusardi (2004), we measure liquidity as founder taxable wealth prior to start-up.[9] Wealth is correlated with greater inventory of liquid assets such as cash or publicly traded stocks and it is also correlated with the inventory of assets that easily put up as a collateral, such as property.

Taxable wealth is a noisy measure of true wealth. In particular, the value of property investments and investments in non-listed stocks have an artificially low tax value. Debt, on the other hand is fully deductible. Financing property and non-listed stocks by debt, therefore, is a common way to avoid the taxation of wealth. For this reason gross taxable wealth is likely to be a better proxy for true wealth than net taxable wealth, and we use this as our main measure. To reduce measurement errors in gross wealth we construct the variable as an average over the three years preceding the start-up year. To assess the robustness of our results, we also use net wealth and net capital income as alternative measures for liquidity.

The model of Evans & Jovanovic (1989) suggests that the relation between wealth and profitability should be initially negative and then fade out when founders become unconstrained and can establish a company at efficient scale. We accommodate this convexity using log gross wealth as our benchmark wealth measure. We later explore the robustness of this specification with respect to other forms of nonlinearities.

[9] In Norway, individuals are liable to pay wealth and income tax every year throughout their lives. In contrast, the U.S. tax system requires wealth reporting only in connection with estate tax, which is imposed only on the very rich at the time of death (Campbell, 2006). Our wealth variable therefore has much better coverage than the measures used in previous research on U.S. data. The only other work we are aware of with a comparable richness in income and wealth measures is Calvet et al. (2006) using data from Sweden.

3.2 Measuring entrepreneurial performance

We use yearly operating returns on assets (OROA) as the benchmark performance measure. OROA is the standard performance measure in a large accounting and financial economics literature (see e.g. Bennedsen et al., 2007, and the references therein). OROA is defined as the ratio of earnings before interest and taxes (EBIT) to the total asset base used to generate them. Unlike returns on equity or returns to capital employed, OROA compares firm profitability relative to total assets. In contrast to net income-based measures such as return on assets, OROA is not affected by capital structure or dividend policy differences across firms. The asset base we use to compute yearly OROA is the average of assets at the beginning and the end of the calendar year. To avoid that outliers drive our results, we have winsorized the yearly OROA values at the 5 percent level and replaced values of gross wealth less than NOK 10 000 with the value 10 000.

In addition to profits, measured by OROA, a start-up normally generates wage income for the entrepreneur. A priori it is not clear whether liquidity affects OROA or entrepreneurial wage more, and we analyze both. All interesting results, however, are captured by the OROA analysis. There is no relationship between wealth and entrepreneurial wages, once the wage history is controlled for. We therefore focus on the OROA analysis and report the wage analysis in Appendix A.

3.3 Control variables

High wealth can reflect omitted variables such as high earnings potential or a greater savviness at investing. We use a battery of controls for such potential underlying traits, in particular the human capital of the founder as measured by age, education and previous wage. Age and education may act as controls for more than just human capital. Age can be correlated with risk attitudes, attitudes toward non-pecuniary aspects of entrepreneurship, and cost of labour supply. Years of education may affect which type of firm an

individual starts up.

In addition, we include dummy variables for the age of the start-up. We also include dummy variables for year and 2-digit NACE industry in order to capture business cycle and industry effects.

4 Empirical analysis

4.1 Descriptive statistics

Table I presents descriptive statistics of the firms and founders in the sample. The figures are close to that reported by previous studies using U.S. data (Hamilton, 2000, Hurst & Lusardi, 2004, or Campbell, 2006). Founders tend to be experienced workers, on average 41 years old, and are relatively wealthy. Start-ups are small, on average they have NOK 2 million (about Euro 250 000) in assets at the end of the first year, with the median being considerably lower.

TABLE 1: Descriptive statistics

N=1307		
	Mean	Median
Start-up year	1999	1999
	(2.4)	
Start-up equity at start-up date	173	101
	(981)	
Start-up assets at the end of first year	2071	772
	(6676)	
Start-up sales in the first year	2695	1143
	(7031)	
Age at start-up date	41	40
	(9)	
Education in years at start-up date	12.8	12
	(2.6)	
Taxable wealth, 3-year average before start-up date	1550	542
	(7614)	
Net capital income, 3-year average before start-up date	-9	-33
	(121)	
Wage income, 3-year average before start-up date	515	437
	(555)	
Founder net capital income, 3-year average after start-up date	57	-6
	(188)	
Founder wage income, 3-year average after start-up date	460	394
	(310)	
Start-up operating return on assets, OROA	.16	.13
	(.34)	
Share of start-ups in non-IT manufacturing	.47	
Share of start-ups in IT	.49	
Share of start-ups in non-IT services	.05	

Krone values are expressed in 1000 2002 kroners. Standard deviations in parenthesis. OROA is winsorized at the 5 percent level.

4.2 Are liquidity constraints present?

In a world without liquidity constraints we would expect there to be no relation between wealth and business size, controlling for other characteristics of the entrepreneur such as age, education and wage history. If liquidity constraints are binding, on the other hand,

wealthy entrepreneurs should come closer to efficient scale, and hence on average start larger companies.

TABLE 2: The effect of gross taxable wealth on start-up size

Dependent variable	ln(equity) at start-up	ln(assets) at end of 1st year
ln(wealth)	.105***	.288***
	(.020)	(.037)
$\ln(\text{wage}_{t-1})$	-.014	.118***
	(.026)	(.045)
$\ln(\text{wage}_{t-2})$	.055*	.071
	(.029)	(.044)
age	-.029*	-.046*
	(.015)	(.025)
age^2	.0003*	.0005
	(.0002)	(.0003)
education in years	.003	.022
	(.008)	(.014)
R^2	.15	.22
N	1307	1307

The estimation method is ordinary least squares. t is the start-up year. Two digit industry dummies and dummies for the year of the start-up are included, but not reported. Robust standard errors in parenthesis.

*** Significant at the 1 % level ** Significant at the 5 % level * Significant at the 10 % level

We see from Table 2 that the estimated effect of wealth on start-up size is highly significant. The elasticity of equity with respect to wealth is 0.105 at the start up date, and the elasticity of assets at the end of the first year with respect to wealth is 0.288. Evaluated at the means this implies that NOK 100 000 higher wealth gives NOK 1200 more in equity at the start up date and NOK 38 500 more assets at the end of the first year. At the medians, the numbers are slightly larger, 2000 and 41 000 respectively. The effect of wealth is substantially larger on total assets than on equity. This is reasonable as a higher founder wealth is likely to ease access to both short term credit and long term debt on the hand of the company.

Our estimates fit reasonably well with previous studies. They are somewhat below

Ando (1995) and somewhat above Holtz-Eakin et al. (1994b). Using survey evidence from U.S. Small businesses, Ando finds that the elasticity of start-up size with respect to founder wealth is around .4. Holtz-Eakin et al. study small business owners who receive a large inheritance and find that each dollar of inheritance induces about 18 cents of investments in their "low-wealth" sample. This consists of entrepreneurs with income from liquid assets less than $10 000.

We use log wage one and two years prior to the start-up year, age and education to proxy for human capital. We include two lags of prior wage because the average of the two lags gives a more precise measure of the human capital level, and because the difference between the two lags allow for a separate effect of wage growth. Generally, we see that the founders' human capital matters for the size of the start-up, which is what one expects if there is a positive relation between human capital and the "size of ideas" or availability of external funding.

Blanchflower & Oswald (1998, p. 28) suggests that a positive relation between wealth and start-up size could be because "inherently acquisitive individuals [may] both start their own businesses and forego leisure to build up family assets". This could cause wealth and start-up size to be correlated even in the absence of liquidity constraints. We would expect such an acquisitive trait to be a rather permanent characteristic of the individual and hence independent of the start-up opportunity. As argued by Buera (2003) and Hurst & Lusardi (2004), liquidity constrained founders, on the other hand, would be expected to accumulate wealth in the run-up to the formation of the start-up. In order to investigate this selection issue, we have analyzed the timing of the wealth accumulation. We find that founders have a marked wealth accumulation in the run-up to the start-up date, a result that also holds when comparing the founders to a control group of non-founders.[10]

The coefficients on wealth in Table 2 are clearly consistent with liquidity constraints

[10]See Appendix A for how this control group was constructed.

being present. It is possible, however, that even if founders are liquidity-constrained at the starting date, once the firm is established outside investors quickly realize which companies are worth investing in, and provide capital to those. Under such an hypothesis, companies that start out small but perform well are hitched up by external investors, while companies that do not perform well would continue to be small or fail to survive. To investigate this question, we analyze whether the relation between wealth and size continues to hold also after the first year, the idea being that the relation between wealth and size should be vanishing if liquidity constraints are transient. To investigate this, we run yearly regressions on the size of the venture, using current profitability as an additional control to those used in Table 2. We find that profitability is an important explanatory factor for size, and that the importance of profitability for size increases over time. We also find, however, that wealth has an approximately constant effect on the size of the company over the first five years. This suggests that liquidity constraints at the start-up date are binding well into the life of the venture.

4.3 The effect of wealth on profitability

In line with Evans & Jovanovic (1989), we start out by using log-linear functional form in order to capture that the relation between wealth and profitability on assets should initially be negative and then fade out when the founder becomes more liquid and can start up the company at an efficient scale.

TABLE 3: Effects of log gross taxable wealth on OROA

	(1)	(2)	(3)	(4)	(5)	(6)
ln(wealth)	.016**	.007	.206***	-6.36**		
	(.007)	(.007)	(.071)	(3.12)		
$\ln(\text{wealth})^2$			-.008***	.702**		
			(.003)	(.350)		
$\ln(\text{wealth})^3$				-.033*		
				(.017)		
$\ln(\text{wealth})^4$				.0006*		
				(.0003)		
Dummy2					-.001	.079***
					(.033)	(.019)
Dummy3					.082***	-.020
					(.031)	(.033)
Dummy4					.076**	
					(.033)	
Dummy5					.169***	
					(.045)	
Dummy6					.047	
					(.046)	
Dummy7					-.016	
					(.051)	
Dummy8					-.017	
					(.049)	
$\ln(\text{wage}_{t-1})$		.023**	.023**	.022**	.020*	.021**
		(.011)	(.011)	(.011)	(.010)	(.010)
$\ln(\text{wage}_{t-2})$		.032**	.031**	.032**	.032**	.033***
		(.013)	(.013)	(.013)	(.013)	(.013)
education in years	.014***	.012***	.012***	.012***	.013***	.013***
	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
age	.001	-.005	-.008	-.010*	-.011**	-.011**
	(.005)	(.005)	(.005)	(.005)	(.005)	(.005)
age^2	-.00004	.00003	.00006	.00008	.00009	.00009
	(.0005)	(.00005)	(.00006)	(.00006)	(.00006)	(.00006)
R^2	.05	.07	.07	.07	.08	.08
N	5832	5832	5832	5832	5832	5832

The estimation method is ordinary least squares. The dependent variable is the yearly OROA. t is the start-up year. In column 5, dummy 2-8 represent the 10-30, 30-60, 60-90, 90-92.5, 92.5-95, 95-97.5, 97.5-100 percentiles of the wealth distribution, respectively. In column 6, dummy 2 represents percentile 30-95 and dummy 3 represents percentile 95-100. Low wealth individuals are the reference category in both columns. Two digit industry dummies, time dummies and dummies for the age of the start-up are included, but not reported. Huber-White robust standard errors allowing for clustering of errors by firms are reported in parenthesis.

*** Significant at the 1 % level ** Significant at the 5 % level * Significant at the 10 % level

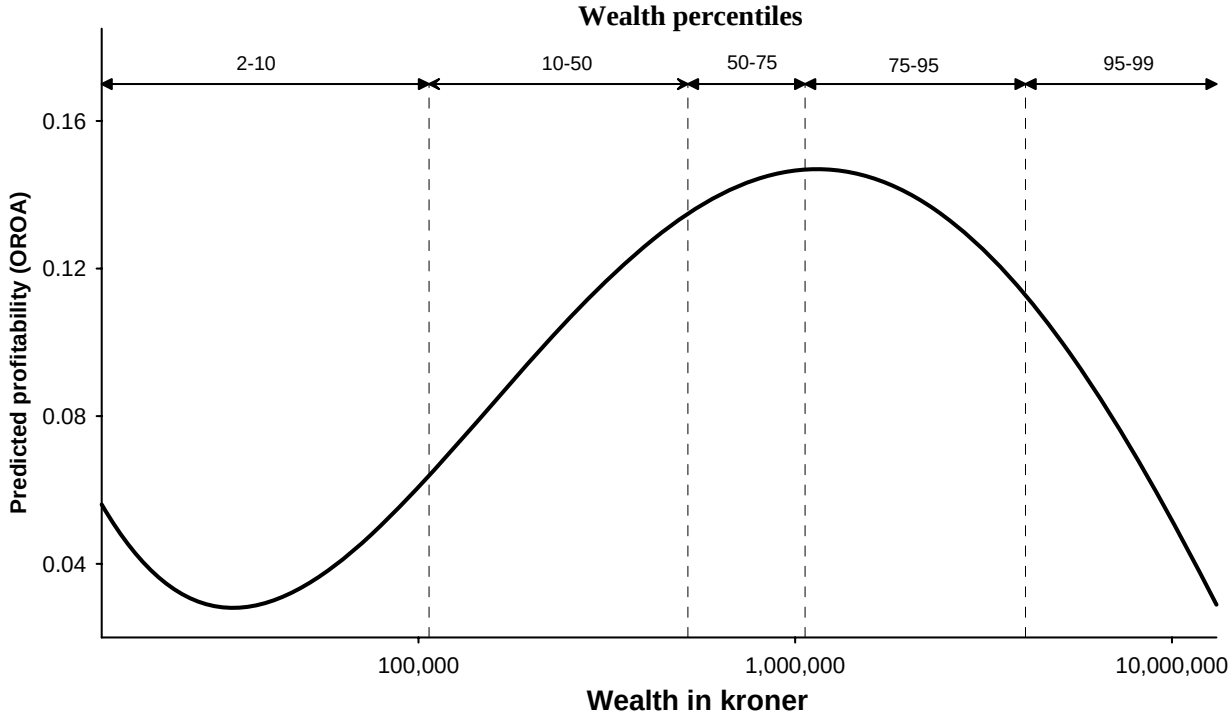
In column (1) we regress profitability on wealth controlling only for age and education. We find a significant positive relation between prior gross taxable wealth and OROA. As discussed in previous sections, however, wealth is likely to be correlated with unobserved human capital (ability), and this may create a positive bias in the wealth coefficient. Looking at column (2) where we include prior wage as a control for ability, we see that this concern is highly relevant. The effect of wealth on wages falls sharply, and now we find none or a slightly positive log-linear relation between gross taxable wealth and profitability on assets.[11] We can note from column (2) that previous wage is very important for entrepreneurial performance. There can be several explanations behind this. First, high wage workers have more knowledge and/or creativity than low wage workers, and are likely to come up with better business ideas. Second, high wage workers have a higher opportunity cost of starting up a company, and hence demand more from their project before going ahead. Third, high wage workers are likely to be better at running their company, once they get started.

The result that there is none or a slightly positive relation between wealth and profitability, once controling for human capital, is not immediately consistent with the Evans & Jovanovic (1989) model, which predicts a convex, and hence a negative loglinear relationship. The loglinear specification may be too restrictive, however, and we explore more flexible functional forms for how wealth can affect profitability in column (3)-(6).

In column (3) we continue to control for human capital and add a quadratic term in log wealth. The quadratic term in wealth turns out significant and negative, indicating a *concave* relationship between wealth and profitability. Since a second-order formulation imposes a symmetry that might or might not be present in the data, we investigate the

[11] It could be that the effect of wealth vary with human capital, but extending the specification by including an interaction term between wealth and prior wage do not give significant results.

concavity further in column (4) and estimate a fourth-order polynomial in log wealth.[12] All coefficients are significant, and in figure 1 we plot the predicted OROA.



The horizontal axis (log scale) runs from NOK 15 000 to NOK 13 million in gross wealth, and covers the 2nd to 99th percentiles as shown in the upper part of the figure. The unit on the vertical axis is operating returns on assets.[13] The effect of wealth on profitability is fairly flat up until about NOK 100 000 (the 10th percentile), then upward-sloping, and reaches a maximum at about NOK 1 million (the 75th percentile), before it falls quite sharply.

The upward-sloping part of the curve in figure 1 is consistent with a production function with a region of increasing returns: For liquidity constrained entrepreneurs, access to more capital increases marginal returns and thus gives a higher average profitability. An

[12] We also tried using a third- and a fifth-order polynomial specifications and the results were very similar.

[13] The constant term is calibrated to fit the second-year performance of a start-up operating in the the median return 2-digit NACE industry and with founder characteristics at mean values.

entrepreneurial production function with a region of increasing returns stands in contrast to the Evans & Jovanovic (1989) model. It suggests a welfare loss since liquidity constraints could stop entrepreneurs with little wealth from being able to exploit a "hump" in marginal productivity. A simple calculation can give an indication of the magnitude of this problem. Individuals in the 0-30 percentile of the wealth distribution represents, at the end of the first year of operations, about 15 percent of the total assets in the sample. Using this figure as a weight, we find that an increase in OROA for the 0-30 percentile up to the same level as that of the 30-60 percentile, would increase overall OROA in the sample by about 1.2 percentage points. Since the smallest start-ups tend to grow faster than the larger start-ups, this figure will be larger if we use asset-weights based on later years.

As an alternative explanation to increasing returns, the upward-sloping part of the curve in figure 1 could be because more wealthy entrepreneurs borrow less than less wealthy entrepreneurs and are thus less exposed to moral hazard, as in Aghion & Bolton (1997). We investigated this possibility by analyzing the relationship between founder prior wealth and the level of debt of the start-up at the end of the first year. As pointed out by Paulson et al. (2006), one would expect this relationship to be negative if the underlying reason for liquidity constraints is moral hazard, while if the underlying reason for liquidity constraints is limited liability, as in Evans & Jovanovic (1989), one would expect it to be positive. The estimates we obtained suggested a strong positive relation between wealth and the level of debt in all wealth groups, with an elasticity of debt to wealth of about .3. Thus the role of moral hazard in explaining the upward-sloping part of the curve in figure 1 seems limited, and we conclude that increasing returns to scale seems the more likely explanation.[14]

[14]The upward-sloping part of the curve could potentially be due to liquidity affecting selection into entrepreneurship. This seems unlikely, though. If credit constraints limit entry into entrepreneurship, we would expect richer individuals to be more likely to start up a business and, controling for human capital, at the extensive margin start up ventures that are less profitable.

The downward-sloping part of the curve in figure 1 is more difficult to explain than the upward-sloping part. A falling liquidity-performance relation on some interval of the wealth distribution is to be expected from models such as Evans & Jovanovic (1989) where marginal profitability decreases as start-ups tend towards their efficient scale. It is, however, puzzling that profitability falls sharply in the region of the wealth distribution where entrepreneurs are least likely to be liquidity constrained. Since the wealthiest founders tend to found the largest companies, their weaker performance has a quite strong impact on overall profitability: The individuals in the top 5 percent of the wealth distribution represents, at the end of the first year of operations, about 26 percent of the total assets in the sample. Thus if the profitability increased to the same level as that of the 30-95 percentile, this would increase the first-year overall profitability in the sample by about 2.5 percentage points.[15] Possible interpretations for why wealth and profitability is negatively related at the top of the wealth distribution is discussed further in Section 4.4. We first discuss the robustness of our findings.

To ensure that the inverse U-shaped wealth-profitability relationship depicted in figure 1 is not driven by outliers, we construct a set of dummies which split the wealth distribution into fine intervals and put very little structure on the estimated relationship. In column (5) dummy 2-8 represent the 10–30, 30-60, 60-90, 90-92.5, 92.5-95, 95-97.5, 97.5-100 percentiles of the wealth distribution, respectively. There are about 35 founders behind each of the top four wealth dummies. Founders in the 0-10 percentiles are the reference category. We find that founders in percentile 10-30 do equally well to the founders in percentile 0-10. Founders in percentiles 30-60 and 60-90 do significantly better than 0-30. Percentile 90-92.5 seems to be a positive outlier, and the concavity is associated with the three dummies representing the top 7.5 percent of the wealth distribution. The

[15] One may also ask whether the lower returns is of any consequence for the founders themselves. The median share of assets to gross wealth is 41 percent in the 95-100 percentile of the wealth distribution. This suggests that the answer to this question is affirmative.

three top dummies are lower than any of the dummies 30-60, 60-90 or 90-92.5, and the two top dummies significantly so, suggesting that the concave relationship between wealth and OROA represents a systematic pattern in our data. In column (6) we accommodate the pattern revealed in column (5) and estimate average effects for founders in percentiles 30-95 and 95-100, relative to founders in percentile 0-30. We find that founders in percentile 30-95 have 8 percentage points higher profitability than founders in percentile 0-30 while founders in percentile 95 to 100 have 2 percentage points lower profitability.[16] The results in column (6) are similar to those depicted in figure 1.

To investigate the robustness of our results further, we have performed several exercises. First, we have re-run the regressions on the three industry classes non-IT manufacturing, IT, and other services. The inverse U-shaped relation between wealth and performance was strongest for IT but holds up within all three industry classes. Second, instead of log gross wealth, we have used two alternative wealth measures, net wealth (gross wealth deducted debt) and net capital income (gross capital income deducted interest payments), both calculated as three-year averages before the start-up year. The results were qualitatively speaking the same as in the main analysis, in that we obtained clear inverse U-shaped relation between liquidity and profitability. Third, we re-ran all regressions using median and robust regressions. The results were the same. Fourth, following e.g., Frank & Goyal (2003) we tried using 3-year weighted average OROA (weighted by the yearly level of assets) as a performance measure rather than yearly OROA. The results of this cross-sectional regression was the same as in the main analysis.

As two alternative performance measures, we have investigated the relation between wealth and entrepreneurial wages and the relation between wealth and business survival. Our analysis of the relation between wealth and entrepreneurial wage, contained in Appendix A, revealed no relationship once the wage history is controlled for. Defining survival

[16] These differences are near identical to the differences in average raw returns for these three wealth classes. The average raw returns are 11 percent, 18 percent and 8 percent, respectively.

to occur if a start-up has submitted a tax report for the fifth year of operations,[17] we find that the start-ups of wealthier founders are more likely to survive. The estimated coefficients suggest that the relationship is quite weak in economic terms. For example, a one log increase in founder wealth gives 6 percentage points higher probability of 5-year survival. This translates into a 1.2 percentage points higher yearly survival rate.[18] In spite of being more highly capitalized, the richest founders (the top 5 percent of the wealth distribution) did not have a higher survival rate than the 30-95 percentile. Thus, our results on survival are quite consistent with our results on profitability.

4.4 Discussion: What's wrong with being wealthy?

In the absence of liquidity constraints, there should be no relation between wealth and profitability. Our empirical results are seemingly at odds with this hypothesis, in that there is a strong negative relation between wealth and profitability in the upper quartile of the wealth distribution. Here we discuss alternative explanations for this finding.

One explanation is that liquidity constraints bind for some of the wealthiest founders, and that such constraints - combined with suitable assumptions about production technology - are sufficiently strong to create a downward slope in profitability. Although we do not observe production technologies, we do observe start-up size, and can therefore construct a measure of liquidity constraints based on the discrepancy between the start-up size and the founder's wealth. We follow Evans & Jovanovic (1989) and define an unconstrained entrepreneur as one whose business is smaller than a multiple λ of net worth. Estimates of λ vary, but tend to be in the region of 1.5-2 (Evans & Jovanovic, 1989, Paulson et al., 2006). We choose the lowest estimate in this region, 1.5, and compare the level of assets

[17] The data does not contain information on whether a start-up ceases to exist due to a liquidiation or due to a buy-out. This reduces the reliability of the survival measure, but buy-outs occur rarely for very young firms so this lack of detail is unlikely to cause much bias.

[18] These magnitudes are very similar to those reported by Holtz-Eakin et al. (1994a).

at the end of the first year with 1.5 times net worth. Entrepreneurs where the level of assets are lower than 1.5 times net worth are defined as unconstrained. We will hereafter refer to this as "EJ-unconstrained". Using this simple and very conservative criterion for whether a founder is unconstrained or not, the fraction of EJ-unconstrained entrepreneurs in the four wealth quartiles are 1 percent, 3 percent, 30 percent, and 39 percent, respectively. When regressing OROA against a fourth-order polynomial in wealth using only the EJ-unconstrained entrepreneurs from the highest wealth quartile, we find that predicted OROA drops by about 20 percentage points from the 75th percentile to the 99th percentile.[19] In contrast, for EJ-constrained entrepreneurs in the 75-99 percentile, predicted OROA is constant or slightly increasing in wealth.[20] Thus the drop in profitability in the highest wealth quartile is due to decreasing performance of the EJ-unconstrained founders. The drop in profitability in the upper wealth quantile therefore seems due to a lack rather than the presence of liquidity constraints.

So why is the relation between wealth and profitability negative for unconstrained entrepreneurs? As suggested by e.g., Hamilton (2000) and Moskowitz & Vissing-Jorgensen (2002), entrepreneurship could be a luxury good that is more likely to be purchased by richer individuals, giving such benefits as being one's own boss and enhanced esteem. Consistent with this idea, Hurst & Lusardi (2004) finds that the relation between wealth and the propensity to start up a company is practically flat in the 0-95 percentile of the wealth distribution, and sharply increasing in the top 5 percent.[21] If wealthy and less wealthy individuals produce business ideas of similar quality when controlling for human

[19] This regressions contains 538 observations of 135 entrepreneurs. Using all EJ-unconstrained entrepreneurs from the upper half of the wealth distribution, rather than from the upper quartile of the wealth distribution, we get almost identical results in terms of predicted OROA.

[20] IT start-ups are on average smaller than start-ups in other industries. Hence, entrepreneurs from the IT industry tend to be over-represented among the EJ-unconstrained. Even excluding IT start-ups, however, we find a significantly negative relation between wealth and profitability for the unconstrained, and no relation for the constrained.

[21] As outlined on page 343 in their paper, this result can only partly be explained by the most wealthy being more likely to work in professions such as law and medicine, where activities are often organized in small firms.

capital, we would from the luxury good hypothesis expect that richer individuals would be more likely to start up a business and would at the extensive margin start up ventures that are less profitable. This hypothesis fits well with Hurst & Lusardi's finding of a higher start-up propensity among the wealthiest and our finding of a lower start-up profitability for wealthy, unconstrained, founders.

Whether richer households are more likely to valuate non-pecuniary aspects of entrepreneurship is difficult to evaluate. Our data contains information on how much effort the entrepreneur spends on the venture, through weekly work hours and through whether the entrepreneur works full-time in the company or not. An entrepreneur dedicated to profitability rather than, say, life-style seems more likely to put in a high number of hours and to be full-time employed. Under our first measure of entrepreneurial effort, weekly work hours,[22] the only significant explanatory variables are age (a negative effect) and previous wage (a positive effect). Wealth has no power. Our second measure of labor supply is the probability that the entrepreneur is employed by the start-up.[23] The results are quite suggestive: While 85 percent of the entrepreneurs in the bottom 95 percent of the wealth distribution worked for the start-up at the end of the second year of operations, the corresponding figure for the entrepreneurs in the top 5 percent is 68 percent. This gives further weight to the luxury good explanation for why wealth and profitability are negatively related, although it is also consistent with the more wealthy simply having a higher opportunity cost of time.

A different explanation of the poorer performance of the unconstrained founders is due to behavioral biases. Survey evidence (e.g., Arabsheibani et al., 2000, Landier & Thesmar, 2003) and experimental evidence (Camerer & Lovallo, 1999) suggests that entrepreneurs are subject to overconfidence and excess optimism about their start-up prospects. Since

[22] This variable is yearly and takes the value of one if the individual works for more than 30 hours a week in that year.

[23] This variable equals one if the entrepreneur has the start-up as main employer at the end of the calendar year.

more liquid founders are less disciplined by outside investors when setting up a company, one could expect this tendency to be stronger for wealthier founders, who may then set up companies that exceed the efficient scale (de Meza & Southey, 1996). To investigate this possibility, we looked at the relation between wealth and business size for the EJ-unconstrained entrepreneurs in the highest wealth quartile, the idea being that under the excess scale hypothesis the relation should be positive. Our analysis of this question suggested that there is no or only a slightly positive relation between wealth and start-up size for the EJ-unconstrained entrepreneurs, thus not giving support to the excess scale hypothesis. We conclude that entrepreneurship being a luxury good for the most wealthy entrepreneurs seems the most likely explanation of why profitability drops significantly in the upper part of the wealth distribution.

5 Conclusion

Prior research has investigated the relation between liquidity and the propensity to start up a business. Evidence on whether liquidity enhances entrepreneurial performance is far more scant. Using a unique dataset from Norway that covers both founders and their start-ups over an extended period of time, we have shown that there is a positive relation between wealth and profitability in the lower 75 percent of the wealth distribution, and a strong negative relation between wealth and profitability in the upper 25 percent of the wealth distribution.

The first of these findings is consistent with a region of increasing returns to scale in the entrepreneurial production function that could seriously impair the performance of liquidity-constrained start-ups. This result is particularly important in view of recent findings by Hurst & Lusardi (2004) that suggest little or no role for liquidity constraints in the decision to start up a business. We complement these findings by showing that,

for a main bulk of the wealth distribution, liquidity constraints incur a large negative effect on the size and performance of start-ups. Our findings thus suggest a possible role for policy in alleviating financial constraints of young businesses. Obviously, such policies may have pitfalls of their own. For example, policy aimed towards improving the liquidity of start-ups could have a detrimental effect on the selection into entrepreneurship. How to design policies to strike the right balance between the quantity and quality of start-ups seems to be a useful area for future research.

That the estimated profitability on assets is decreasing on some interval is what one would expect from the Evans-Jovanovic (1989) model, where marginal profitability decreases as start-ups reach their efficient scale. It is, however, rather puzzling that the profitability falls sharply in the region where entrepreneurs are not liquidity constrained. Our analysis suggests that the luxury good aspect of entrepreneurship seems the most likely explanation.

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6 Appendix: Entrepreneurial wages

In addition to generating a stream of profits, the start-up generates a stream of wage income for the entrepreneur that is traceable with the tax data. To evaluate the effect of wealth on entrepreneurial wages, we construct a control group of individuals that are similar to the founders in terms of gender, wage, wealth, age and education.[24] The idea behind the control group is that although estimates of the wealth coefficient may be biased, the difference in wealth effects between entrepreneurs and observably similar workers that do not become entrepreneurs are less likely to be biased.

Table 4 presents descriptive statistics of the founders versus control group. We see that the two groups are quite similar. The control group have slightly lower gross taxable wealth and net capital income before the start-up date, suggesting that they have slightly less debt. With respect to wage before the start-up date, we see that the two groups are very similar. After the start-up date, however, the control group have a wage increase while the founders have a wage decrease. This decrease is partly compensated for through a stronger increase in net capital income.

[24] The control groups is constructed by sorting the entire population of individuals by gender, wage (rounded to the nearest 20 000), wealth (rounded to the nearest 20 000), age and education, year by year. For each founder, we have selected the two closest neighbours in the start-up year ranking, excluding neighbours that are founders.

TABLE 4: Descriptive statistics

	Founders		Control group	
	Mean	Median	Mean	Median
Age at start-up date	41	40	42	41
	(9)		(10)	
Education in years at start-up date	12.8	12	12.9	12
	(2.6)		(2.7)	
Taxable wealth, 3-year average	1550	542	1240	517
before start-up date	(7614)		(3670)	
Net capital income, 3-year average	-9	-33	-5	-23
before start-up date	(121)		(117)	
Wage income, 3-year average	515	437	494	415
before start-up date	(555)		(502)	
Founder net capital income, 3-year	57	-6	12	-21
average after start-up date	(188)		(138)	
Founder wage income, 3-year	460	394	533	444
average after start-up date	(310)		(452)	

Krone values are expressed in 1000 2002 kroners. Standard deviations in parenthesis.

We now study the relation between wealth and entrepreneurial wages.

TABLE 5: The effect of prior wealth on entrepreneur wage

	(1)	(2)	(3)	(4)	(5)	(6)
	Wage for entrepreneurs			Wage for control group		
ln(wealth)	.073***	.015	.081	.111***	.039***	-.094
	(.017)	(.017)	(.171)	(.012)	(.011)	(.102)
$\ln(\text{wealth})^2$			-.003			.005
			(.007))			(.004)
$\ln(\text{wage}_{t-1})$		.156***	.156***		.295***	.295***
		(.033)	(.033)		(.039)	(.039)
$\ln(\text{wage}_{t-2})$		.178***	.179		.223***	.221***
		(.034)	(.033)		(.042)	(.039)
age	.045***	.005	.004	.059***	.012	.014*
	(.013)	(.013)	(.013)	(.008)	(.007)	(.008)
age^2	-.0005***	-.0001	-.0001	-.001***	-.0002*	-.0002***
	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)	(.00008)
education in years	.039***	.025***	.025***	.071***	.046***	.044***
	(.007)	(.007)	(.007)	(.005)	(.004)	(.004)
R^2	.07	.15	.15	.19	.39	.39
N	6760	6760	6760	12593	12593	12593

The estimation method is ordinary least squares. t is the start-up year. The dependent variable is yearly ln(wage) for the entrepreneur after start-up, excluding the start-up year. Two digit industry

dummies, time dummies and dummies for the age of the start-up are included, but not reported. We report Huber-White robust standard errors allowing for clustering of errors by individuals.

*** Significant at the 1 % level ** Significant at the 5 % level * Significant at the 10 % level.

In column (1) we regress wealth on wage controlling only for age and education. We find a significant positive relation between prior gross taxable wealth and entrepreneurial wages. Note, however, from column (4) that the wage effect is even stronger in our matched control group of non-entrepreneurs. A likely explanation is that wealth is correlated with unobserved human capital (ability). Introducing prior wage as a control for ability in column (2) we see that the effect of wealth on wages falls sharply and becomes insignificant. Prior wealth still has a significant effect in the matched control group of non-entrepreneurs, see column (5). This is probably because the sample size is larger and the wage variance smaller. Measured human capital has more explanatory power, and R-square is far higher for non-entrepreneurs than for entrepreneurs. We see from column (3) and (6) that the quadratic term enters with a small and non-significant coefficient in the wage regressions. Thus there is no evidence of a non-linear relationship between log wealth and entrepreneurial wage. We have also tried to include third and fourth order polynomials in wealth, reaching the same conclusion. To further assess robustness, we have used median and robust regressions, but the results were still the same. Taken together, this analysis suggests that prior wealth has no effect on entrepreneurial wages.